Roads and Ecological Infrastructure

Concepts and Applications for Small Animals

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Figure 4.6. Viewed from within this wetland, the road lies just 3 m away. The litter in the foreground is proof of habitat degradation resulting from the road's proximity and consequent human access. This proximity can also mean that animals using the wetland are vulnerable to poaching or illegal harvest. *Credit: Steven P. Brady.*

Road networks intended for energy and timber extraction can inadvertently cause problems associated with increased access to wildlands when the roads are accessible to unintended users (see Case Study 4.5.1.1; Havlick 2002).

In fire-prone regions, road access can increase the frequency of wildfires. Many such fires are caused accidentally by carelessly discarded cigarettes along a roadside. Some fires may be accidental escapes of campfires made by people who have traveled by road. However, some fires are lit intentionally to clear vegetation from the land adjacent to a road, or by arsonists who can conveniently access a flammable target, start a fire, and leave the area before detection.

The most important solution to access issues is to minimize new road construction through environmentally sensitive wildlands. Where road networks are needed for resource extraction, however, locked gates or legal mechanisms should be used to prevent unintended users from exploiting the roads. There should be a contractual obligation to remove resource extraction roads or make them impassable once they are no longer needed. To reduce access to the adjacent landscape, safe parking places along the road should be restricted to those areas that are the least environmentally sensitive. Fencing can also be used to impede access to the landscape around the road.

4.5.1.1. Case Study: Road Proliferation due to Rapid Renewable Energy Development

Jeffrey E. Lovich

Renewable energy development, especially to harness wind and solar resources, is proceeding rapidly worldwide, particularly in the United States. The potential scale of road building associated with renewable energy development is significant by virtue of the large footprint of facilities (McDonald et al. 2009). For example, solar energy development is currently being considered on some portions of almost 40 million hectares of public land in 6 southwestern states (Lovich and Ennen 2011) including Arizona, California, Colorado, Nevada, New Mexico, and Utah. In addition, worldwide wind energy development exhibited a 15-fold increase in generating capacity between 1995 and 2006 (Golait et al. 2009), with 23% annual growth rates in the United States from 2000 to 2009 (Wilburn 2011). Associated with this surge in development is an increase in road building to provide access to wind turbines and solar arrays. Although the effects of roads on wildlife are well documented, little research has been conducted on their effects relative to renewable energy development (Lovich and Ennen 2013).

Since many renewable energy facilities are in remote areas, roads are built to provide access to both the general site and to specific infrastructure within a site. For example, roads are necessary to provide access to individual wind energy turbines for construction and maintenance. These roads can be paved, covered with gravel, or bladed into native soil and rocks. Water and wind erosion is a significant problem when wind energy development occurs in hilly or mountainous terrain (Wilshire and Prose 1987). Roads built on other than flat terrain require culverts to direct runoff away from the roadbed, and culverts by themselves can have adverse impacts on wildlife.

The various effects of roads on wildlife, including effects on mortality, behavior, and on the nearby environment, can all similarly result from roads at renewable energy sites. Agassiz's desert tortoise (*Gopherus agassizii*) is a federally threatened species that occurs in wind energy facilities near Palm Springs, California. Tortoises at the site have been the focus of ecological research since 1995, about 12 years after wind energy was established. In the mid-1990s, Lovich and Daniels (2000) concluded that burrows constructed by tortoises were located closer to dirt roads than random locations without burrows, and suggested that the herbivorous tortoises might use roads as foraging microenvironments because of roadside vegetation enhancement in the desert (Johnson et al. 1975). Although this association may appear to be beneficial, it also increases the probability of tortoise mortality from vehicle collisions (von Seckendorff Hoff and Marlow 2002; Lovich, Ennen, Madrak, Meyer, et al. 2011).

Additional research on tortoises at a Palm Springs wind energy facility with a dense network of roads found few differences in the growth rate, annual survivorship, or population structure of tortoises compared to more natural populations (Lovich, Ennen, Madrak, Meyer, et al. 2011). Nesting ecology is also comparable to that reported from populations in natural areas (Ennen et al. 2012), and nesting burrows were not located closer to turbines and roads. Continued research at the site suggests that tortoises no longer use areas near concentrations of turbines and roads as frequently as they did in the past (Lovich, unpublished data).

Although culverts are widely promoted as safe passages for wildlife under roads, they can also have negative consequences (Lovich, Ennen, Madrak, Grover, et al. 2011). In one case, a radio-tagged male tortoise used a culvert in a wind energy facility as a burrow surrogate. Heavy rains filled the culvert with a slurry of sand, entombing the tortoise for several weeks. After the tortoise was exhumed, it was released and lived less than 18 days before dying of cardiac and pulmonary complications associated with the burial. Ignition points for fire in the California deserts can also be directly associated with roads (Brooks and Matchett 2006) and are another source of wildlife injury and death.

Simple mitigation measures may ameliorate some of the negative effects of roads associated with renewable energy. Designing roads with larger concrete box culverts may reduce or eliminate the wildlife mortality occurring in small tubular 0.61 m steel culverts that are easily plugged by runoff. Slow speed limits and speed bumps at renewable energy facilities may further reduce vehicle collisions with slow-moving species like tortoises and rattlesnakes. Training facility personnel to be aware of wildlife on and around roads is another low-cost method with the potential to reduce vehicle impacts.

4.5.2. Invasive and Subsidized Species

Road verges are notorious as pathways for the spread of invasive species, including plants as well as animals (Mortensen et al. 2009). Verges are usually highly disturbed, especially during construction, allowing footholds for noxious weeds. Noxious weeds not only change native habitats that many small animals depend on, but these areas may become reservoirs of harmful chemicals used to treat noxious weeds, thus creating a secondary impact from toxicity. Roads can facilitate the spread of invasive plant species into habitats further from the road verge, potentially displacing native vegetation (Tyser and Worley 1992; Parendes and Jones 2000; Tikka et al. 2001; Mortensen et al. 2009).

In Australia, it was determined that roads and trail systems facilitated the range expansion of the invasive cane toad (*Rhinella marina*) across the country (Seabrook and Dettman 1996), which is now expanding its range at >50 km per year. In the southeastern United States, fire ants (*Solenopsis invicta*) have proliferated along roadsides (Stiles and Jones 1998) and will prey upon reptile nests (e.g., Allen et al. 2001; Buhlmann and Coffman 2001; Parris et al. 2002). In addition, subsidized predators, such as raccoons, are often found along roadsides or near other human-altered landscapes seeking food refuse and carrion (Hoffman and Gottschang 1977; Gehrt et al. 2002; Prange et al. 2004); reptile and bird nests (including both adults and young) in these areas are then potentially vulnerable to those predators' opportunistic depredation.

4.5.3. Development

Roads can facilitate development by providing improved access to agricultural, natural, or rural areas (Moon 1987; Ewing 2008). This leads to significant loss of habitat and increased fragmentation and barrier